

***Feasibility Study Preliminary
Documented Safety Analysis
for In Situ Grouting in the
Subsurface Disposal Area***

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**Idaho
Completion
Project**

Bechtel BWXT Idaho, LLC

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Feasibility Study Preliminary Documented Safety Analysis for In Situ Grouting in the Subsurface Disposal Area

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ABSTRACT

This Feasibility Study Preliminary Documented Safety Analysis is a safety basis analysis for in situ grouting (ISG) at the Idaho National Engineering and Environmental Laboratory. It supports remedial decisions for Operable Unit 7-13/14, Waste Area Group 7, which is the Radioactive Waste Management Complex Subsurface Disposal Area.

In situ grouting would create a solid monolith of buried waste to prevent subsidence and reduce contamination migration. It would be created by injecting grout using a crane-mounted drilling and grouting rig housed in a mobile containment system. The hazard analysis considers two alternatives: (1) anywhere in the area, including transuranic waste areas, and (2) only in the low level waste areas. Some transuranic pits may be pretreated with in situ thermal desorption.

The highest hazards are from projectiles or high-pressure grout generated by pressurized grouting system failure; from direct radiation from buried high radiation waste; or from airborne contamination caused by uncovering the waste or an underground explosion.

The analysis shows ISG can be conducted safely. The grouting system will be safety significant and new Technical Safety Requirements (TSRs) will be required for the grouting system high-pressure protection features. Existing TSRs will protect against exposing high radiation sources. The radiation protection program will ensure the soil cover is maintained and control access to the containment.

EXECUTIVE SUMMARY

This executive summary provides an overview of the safety basis for in situ grouting (ISG) at the Radioactive Waste Management Complex (RWMC) Subsurface Disposal Area (SDA) within the boundaries of the Idaho National Engineering and Environmental Laboratory (INEEL). Sufficient information is presented to establish a top-level understanding of ISG at the SDA and the results of this Feasibility Study Preliminary Documented Safety Analysis (FS-PDSA).

The purpose of this FS-PDSA is to support remedial decisions for Operable Unit (OU) 7-13/14, which comprises the comprehensive remedial investigation and feasibility study for Waste Area Group (WAG) 7 at the INEEL. Waste Area Group 7 is the RWMC, which includes the SDA, a storage area for transuranic (TRU) waste, and miscellaneous support operations.

Information developed throughout the remedial investigation/feasibility study process is cumulatively evaluated to assess data collection activities, assumptions, and the overall strategy for completing the remediation of WAG 7. Administrative implementability is an uncertainty associated with candidate technologies for remediating the SDA. This FS-PDSA provides the basis for evaluating the safety issues and concerns associated with the technology and its implementation in the SDA.

E-1. FACILITY BACKGROUND AND MISSION

The RWMC was established in the early 1950s as a disposal site for solid low-level waste generated by operations at the INEEL and other U.S. Department of Energy (DOE) laboratories. Radioactive waste materials were buried in underground pits, trenches, soil vault rows, and one aboveground pad (Pad A) at the SDA. Radioactive waste from the INEEL was disposed of in the SDA starting in 1952. Rocky Flats Plant (RFP) TRU waste was disposed of in the SDA from 1954 to 1970. Post-1970 TRU waste is kept in interim storage in containers on asphalt pads at the Transuranic Storage Area (TSA).

In August 1987, in accordance with the Resource Conservation and Recovery Act (RCRA)¹ Section 3008(h), DOE and the U.S. Environmental Protection Agency (EPA) entered into a Consent Order and Compliance Agreement.² The consent order and compliance agreement required DOE to conduct an initial assessment and screening of all solid and hazardous waste disposal units at the INEEL and set up a process for conducting any necessary corrective actions. On July 14, 1989, the EPA (under the authority granted to them by the Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] of 1980,³ as amended by the Superfund Amendments and Reauthorization Act of 1986)⁴ proposed that the INEEL be listed on the 1989 National Priorities List.⁵ The final rule that listed the INEEL on the National Priorities List was published on November 21, 1989, in Title 54 of the Federal Register (FR) 48184, "National Priorities List of Uncontrolled Hazardous Waste Sites; Final Rule."⁶ On December 4, 1991, because of the INEEL's listing on the National Priorities List, DOE, EPA, and the Idaho Department of Health and

Welfare entered into the Federal Facility Agreement and Consent Order for the Idaho National Engineering Laboratory.⁷

The strategy for assessing buried waste at the INEEL under the Comprehensive Environmental Response, Compensation, and Liability Act (42 USC § 9601 et seq.) includes the analyses of waste treatment technology options for the remediation of the RWMC. The waste under investigation is buried in the SDA within the RWMC. The types of remedial alternatives being evaluated for the buried waste include containment, in situ treatment, retrieval and ex situ treatment, and combinations of technologies. Seven preliminary remedial action alternatives for remediation of the SDA have been identified in the “Preliminary Evaluation of Remedial Alternatives for the SDA” (PERA) report.⁸ The ISG technology is one of the alternatives among the situ technologies under evaluation.

E-2. FACILITY OVERVIEW

The purpose of ISG is to create a solid monolith of the buried waste to prevent subsidence and reduce contamination migration. The monolith is created by injecting grout in a relatively tight pattern directly into the soil and waste matrix. Grouting has also been considered a pretreatment for eventual retrieval of the buried waste or a post-treatment after in situ thermal desorption.

Two types of grout are being considered:

- Cementitious—There are several cementitious grouts that have been specifically designed for block encapsulation of buried waste by the jet-grouting process. Some have been field-tested successfully at INEEL.
- Paraffin grout—This is a low-temperature, natural paraffin, wax-based material. Molten paraffin is injected at about 160°F. Additives within the molten paraffin allow the paraffin to bond with and permeate soil regardless of moisture content and bond to water, oil, and buried debris.

The proposed ISG apparatus consists of a Mobile Containment System (MCS) that houses a crane-mounted drilling and grouting rig. The rig is supplied through high-pressure hoses by a high-pressure positive displacement pump and a low-pressure feed pump from a hopper assembly. The MCS consists of a rigid, rectangular platform substructure and a flexible, steel-framed superstructure. The outer dimensions of the substructure are approximately 45 × 42 ft with an 18-ft square opening through which the grouting operation takes place. The substructure consists of braced-steel structural shapes and a floor plate to provide rigidity. The steel-framed superstructure is completely covered by a polyester cover that is tensioned over the frame to provide a tight-fitting shell. Crane runway beams are integrated into the substructure on two sides of the opening. The height of an MCS unit will vary depending on the height of the drill rig mast that the MCS encloses. Heights are expected to range from 30 to 45 ft. The pumps, hopper, and control station are outside the MCS.

A 4-ft-high crawler track assembly with an electric drive motor is mounted to the underside of each of the four corners of the platform and moves the MCS

into place above each grouting area. The crawler tracks are sized to produce a pressure on the soil of no more than 500 lb/ft². These crawler assemblies are outfitted with hydraulic cylinders that level the structure after each move. The hydraulic leveling system also may be used for recovery from a subsidence event. The structure must be leveled after each move to prevent detrimental vertical deflection of the runway rails and bridge during drilling operations.

Grout containment sheet pilings will be inserted into the soil before the MCS is moved into position to create a berm for containment of any grout returns. Grout returns are the quantities of grout that return to the surface after being injected into the ground.

Grout injections are made in a triangular pitch matrix with approximately 20-in. spacing between holes. A 9-cm diameter drill stem is driven into the soil waste matrix using rotopercussion. Most insertions into buried debris are accomplished within a 1–2-minute drilling time. While drilling, a slow trickle flow of grout is injected at the bit end of the nozzle to reduce friction. The technology involves driving a drill stem into the waste and, once inserted, injecting grout through the rotating drill stem while withdrawing the drill stem in precise increments. The grouting injection pressure will be determined during system design and is expected to be approximately 6,000 psi. Through repeated applications, a series of interconnected columns form a solid monolith out of the soil and waste seam.

The ISG delivery system works on pits, trenches, and soil vaults. Because the pits are irregularly-shaped polygons with relatively long runs of straight edges, the system moves in a straight line as if it were plowing a field. When it comes to the edge of a pit, the system moves laterally, reverses direction, and begins grouting another straight line. Conversely, the trenches and soil vaults are long, straight runs of, more or less, parallel rows approximately 3–6 ft wide and up to hundreds of feet long.

The MCS controls contamination spread during drilling and grouting. The area inside the MCS is maintained at negative pressure by a high-efficiency-particulate-air-filtered air-handling system. The drill and grouting equipment is operated remotely. Personnel operate the system from the operating gallery and enter the MCS only to perform maintenance and only when the system is not operating.

A promising combination of treatments consists of combining an in situ thermal desorption (ISTD) pretreatment followed by ISG. Pits 4, 5, 6, and 10 are being considered for pretreatment. In ISTD, heat flows into the contaminated media by conduction from buried heaters operated at 1,292–1,472°F. These high temperatures remove and destroy organic sludges, nitrate sludges, combustible solids, and graphite wastes. The vaporized constituents are drawn by vacuum into an off-gas treatment system that removes remaining contaminants. In situ grouting would be applied after ISTD to further stabilize the subsurface area and fill in voids created by destruction of waste materials.

Areas that have been pretreated with ISTD will not require any special preparations for grouting. The treated areas are estimated to encompass approximately 2.6 acres. They will be contoured to create a smooth working surface. The subsurface conditions may have changed because of ISTD destruction of organic material creating additional voids. There may be up to 10 ft additional soil overburden added, which will reduce the potential for subsidence from voids created by ISTD. Also, there will be buried heaters and header piping used to implement ISTD. The piping will have been pumped full of grout to stabilize the piping and immobilize residual contamination.

E-3. FACILITY HAZARD CATEGORIZATION

The RWMC SDA had been designated as a Hazard Category 2 facility. Since this work is being performed in the SDA and involves intrusion into the waste, this activity is Hazard Category 2.

E-4. SAFETY ANALYSIS OVERVIEW

This section presents the methodology and results of the hazard analysis for in-situ grouting (ISG). The baseline assumption for this assessment is no pretreatment of the buried waste and that the ground and buried waste are at normal ambient temperature. Because ISTD is being considered as a pretreatment for some areas that will subsequently be stabilized by grouting, the effects from having been pretreated are also considered.

The hazard analysis considers two alternatives for ISG:

1. In situ grouting would be done anywhere in the SDA, including TRU pits and trenches, LLW pits and trenches, and soil vaults. This first option is the enveloping case since it includes all hazardous materials and hazards in the SDA that could affect grouting.

TRU Pits 4, 5, 6, and 10 are being considered for ISTD pretreatment. They contain organic sludges, nitrate sludges, combustible solids, and graphite wastes, all contaminated with plutonium. The safety analysis for performing ISTD has been performed in a separate FS-PDSA; however, the impact on ISG of having been pretreated by ISTD is discussed for this alternative.

2. In situ grouting would be done only in the LLW pits, trenches, and soil vaults. This second option would be done as an early action to accelerate stabilization of the SDA. This second option is less severe because it does not need to consider hazards uniquely associated with the TRU pits and trenches. In situ thermal desorption is only being considered for TRU pits, so it will not be evaluated for early action areas.

The inventory in the SDA generally consists of solid radioactive waste from the INEEL, the RFP, and other off-site generators. This analysis addresses all waste types buried in the RWMC SDA, including transuranic (TRU) waste, contact-handled low-level waste (CH-LLW), and remote-handled low-level waste (RH-LLW). It also addresses nonradioactive contaminants that are part of the mixed TRU and LLW waste.

The areas of interest include the closed pits 1–16, the open pits 17–20, all trenches (1–58), all soil vault rows (1–21), and Pad A. The waste on Pad A will not be treated there, but may be transferred to a pit for disposal and treatment.

TRU waste is radioactive waste that contains alpha-emitting radionuclides with an atomic number greater than 92 (elements heavier than uranium) and a half-life greater than 20 years. During the period when TRU waste was buried in the SDA, TRU waste was defined to have an activity concentration greater than 10 nCi/g. Transuranic waste is of particular concern because of its long-lived radioactivity and high radiological dose consequences when inhaled. Transuranic waste disposal was terminated at the SDA in 1970. Subsurface Disposal Area Pits 1–6 and 9–12, and trenches 1–10 are known to contain TRU waste. Trenches 11–15 are also suspected to contain TRU waste. Rocky Flats Plant waste in drums and boxes was disposed in Pits 11 and 12 through 1972. Later these drums were retrieved and the TRU drums placed in the Transuranic Storage Area. The boxes were left in Pits 11 and 12, so TRU waste could have been disposed then. Also, there are a small number of TRU drums on Pad A.

Non-TRU waste is LLW that contains beta- and gamma-emitting radionuclides. Low-level waste is still being disposed. Low-level wastes from the INEEL are in all pits and trenches, and include activation products and fission products from reactor operations, processing, and other activities. Low-level waste is classified by its handling requirements as contact handled (CH) or remote handled (RH). Remote handled LLW has exposure rates above 500 mR/h at 1 m from the waste package surface. Subsurface Disposal Area shipping records show the SDA pits and trenches contain 861 packages with surface radiation exposure rates above 1 R/hr at the time of disposal. Exposure rates for materials in the soil vaults have not been characterized, but are expected to be similar. Remote handled LLW was buried in pits, trenches, and soil vaults.

The RWMC contains large quantities of nonradioactive contaminants. The most abundant and hazardous contaminants are sodium and potassium nitrates; organics, particularly carbon tetrachloride; and metals such as lead, beryllium, and zirconium. If performed, ISTD will reduce the inventory of hazardous materials in the treated areas, particularly through reduction of nitrates and destruction of organics.

In the early action areas there are no TRU nuclides and some of the nonradioactive hazardous contaminants are not present.

Potential hazards associated with the project are identified through reviewing existing safety documents, design and process descriptions, operating history, and the DOE Occurrence Reporting and Processing System (ORPS) computer database. A what-if checklist-type analysis was also performed. The result is a comprehensive list of applicable hazards. All the hazards determined to be significant or not routinely encountered are analyzed further. The hazards evaluated are:

- High-pressure mechanical components
- Fissile material

- Direct radiation from buried sources
- Radioactive materials and nonradioactive hazardous materials that might be released
- Fires and explosions
- Natural phenomena
- External events.

These hazards and associated accidents are identified and grouped (binned) in accordance with DOE-STD-3009-94.⁹ The applicable hazards are evaluated qualitatively to identify potential unmitigated release or exposure scenarios. For each scenario, preventive and mitigative features are listed and consequence and frequency levels are assigned. The consequences and frequencies of accidents are combined in risk matrices to determine if safety-class or safety-significant structures, systems, and components (SSCs) are required, and if technical safety requirements (TSRs) or other safety requirements are needed.

The hazard evaluation shows the highest hazards are from projectiles or high-pressure grout generated by pressurized grouting system failure, from direct radiation resulting from exposure of high radiation buried waste, or airborne contamination resulting from uncovering the waste or from an underground explosion in the waste.

The grouting system is being designed to incorporate operational safety features and protect workers from the hazards of high pressure grouting. These include the following features:

- High-pressure grout equipment should be a safety significant system, structure, or component (SSC) and include features recommended following a failure at the RWMC
- The MCS is designed to prevent contamination from spreading
- The MCS track design will limit soil disturbance and subsidence
- The MCS is designed to remain intact if there is subsidence
- Workers will not be permitted inside the MCS during grouting operations
- The operating gallery and maintenance glovebox reduce the need to enter the MCS operating area
- The MCS will be sealed while being moved between setups.

New TSRs will be required to verify the condition of the high-pressure grouting system. Grouting will be performed under the existing RWMC TSR requirements for operating and maintenance procedures. A TSR requiring a radiation protection program is not included because this program is required by 10 CFR 835.¹⁰ The radiation control program will protect workers by limiting

access to the MCS during grouting operations and by ensuring the soil cover is in place.

The soil cover is the first barrier to the release of hazardous materials during normal operation. Only small quantities of hazardous materials will be brought to the surface through the drill string and grout returns, and these will be mixed with the grout and not susceptible to release. The drill shroud and grouting MCS provide multiple barriers to protect against spreading contamination during normal operations and potential accidents.

A bounding and representative set of accidents is selected from the accidents identified in this hazard evaluation. The following design basis accidents are evaluated.

- Failure of the MCS
- Uncovering high radiation sources
- An explosion in the waste.

The results from the quantitative analysis of exposures to radioactive and nonradioactive hazardous materials and a comparison of these results to evaluation guidelines established by the U.S. Department of Energy Idaho Operations Office (DOE-ID) are summarized in Table E-1 for radioactive materials and in Table E-2 for nonradioactive hazardous materials.

In areas pretreated with ISTD, the pretreatment will have minimal effect on the radioactive releases and doses; however, ISTD pretreatment will have destroyed much of the nonradioactive hazardous material. At least 50% of the carbon tetrachloride and other chlorinated hydrocarbons, and up to 80 % of the nitrates, will be destroyed in situ in the pretreated areas. Additional volatile hydrocarbons will have been driven off by the ISTD off-gas and destroyed in the off-gas treatment system; thus, the quantity of carbon tetrachloride and other volatile organics in the ground will be reduced by at least 50%, and possibly up to 100%. The sodium nitrate will be reduced by up to 80%.

The radiation evaluation guidelines for the collocated worker and off-site public are not exceeded in any of the scenarios.

E-5. ORGANIZATIONS

Bechtel BWXT Idaho, LLC, is responsible for the environmental remediation program at the INEEL. The INEEL's Idaho Completion Project (ICP) executes this responsibility. The project manager reports directly to the Clean/Close RWMC project director.

Organizations conducting work in the RWMC are directly accountable to the Clean/Close RWMC facility authority/operations manager for work planning, control, execution, safety, and compliance. The ICP functional support service requirements are presently being evaluated, and this section should be revised once those entities have been identified.

Table E-1. Postulated accident scenarios and results from analysis of radioactive material releases.

Accident Scenario	Frequency Category	Worker Evaluation		Public Evaluation	
		Collocated Worker Total Effective Dose Equivalent (rem)	Guidelines for Total Effective Dose Equivalent (rem)	Public (6 km) Total Effective Dose Equivalent (rem)	Guidelines for Total Effective Dose Equivalent (rem)
Failure of the MCS					
- Limiting Source Term	Unlikely	1.9 E-2	25	2.7 E-5	5.0
- Best Estimate Source Term	Anticipated	1.7 E-2	5.0	2.3 E-5	0.5
Failure of the MCS in early action areas					
- Limiting Source Term	Unlikely	3.9 E-4	25	5.3 E-7	5.0
- Best estimate Source Term	Anticipated	4.5 E-5	5.0	6.1 E-8	0.5
Direct radiation exposure	Unlikely	Negligible	25	Negligible	5
Underground Drum Explosion					
- Best Estimate Source Term	Extremely Unlikely	2.4 E-1	100	3.3 E-4	25
Underground Explosion in early action areas					
- Best Estimate Source Term	Extremely Unlikely	5.8 E-3	100	7.9 E-6	25

Table E-2. Postulated accident scenarios and results from analysis of nonradioactive material releases.

Accident Scenario	Substance	Collocated Worker Exposure Concentration (mg/m ³)	Worker Evaluation Guidelines (mg/m ³)	Public (6 km) Exposure Concentration (mg/m ³)	Public Evaluation Guidelines (mg/m ³)
Failure of the MCS					
Limiting Source Term	Beryllium	6.4 E-5	0.025	8.7 E-8	0.005
	Carbon Tetrachloride*	6.0 E+0	639	8.2 E-3	128
	Sodium Nitrate*	1.0 E-1	7.5	1.4 E-4	1
Best Estimate Source Term	Beryllium	7.6 E-7	0.005	1.0 E-9	0.002
	Carbon Tetrachloride*	1.5 E-1	128	2.1 E-4	31.5
	Sodium Nitrate*	1.3 E-3	1	1.7 E-6	0.4
Direct Radiation Exposure					
	None	0	Not Applicable	0	Not Applicable
Underground Hydrogen Explosion					
Best Estimate Source Term	Phosgene	4.5 E-1	4	6.1 E-4	0.8
	Carbon tetrachloride*	2.6 E+1	4790	3.6 E-2	639
	Sodium nitrate*	7.1 E-2	100	9.8 E-5	7.5

* = not present in early action areas

E-6. SAFETY ANALYSIS CONCLUSIONS

This analysis shows that in situ grouting can be conducted safely at the RWMC. The high-pressure grouting system should be designated a safety significant SSC. New TSRs will be required to verify the operability and condition of the grouting system high pressure protection features. Existing TSR requirements for procedures and training will protect against the hazards from exposing high radiation sources. The existing radiation control program will assure the soil cover is maintained and control access to the MCS to protect against releases of hazardous materials.

E-7. DOCUMENTED SAFETY ANALYSIS ORGANIZATION

Though this FS-PDSA follows the format and content delineated in DOE-STD-3009-94, "Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports," references are made to the main body of the RWMC SAR and SAR-100, "INEEL Standardized Safety Analysis Report (SAR) Chapters,"¹¹ for site characteristic information and institutional program summary information required by DOE-STD-3009-94.

E-8. REFERENCES

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ACRONYMS

AMWTP	Advance Mixed Waste Treatment Project
ARF	airborne release fraction
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CH-LLW	contact-handled low-level waste
COCA	Consent Order and Compliance Agreement
DOE	U.S. Department of Energy
DOE-ID	U.S. Department of Energy Idaho Operations Office
DR	damage ratio
EG	evaluation guidelines
EPA	U.S. Environmental Protection Agency
FDSA	final documented safety analysis
FFA/CO	Federal Facility Agreement and Consent Order
FR	Federal Register
FS	feasibility study
HDT	Historical Data Task
HVAC	heating, ventilation, and air conditioning
INEEL	Idaho National Engineering and Environmental Laboratory
ISG	in situ grouting
ISTD	in situ thermal desorption
LLW	low-level waste
LPF	leak path factor
MCS	Mobile Containment System
NPL	National Priorities List
ORPS	Occurrence Reporting and Processing System

OSH	occupational safety and health
OU	operable unit
PDSA	Preliminary Documented Safety Analysis
PRD	program requirements document
RCRA	Resource Conservation and Recovery Act
RFP	Rocky Flats Plant
RH-LLW	remote-handled low-level waste
RPDT	Recent and Projected Data Task
RSAC	Radiological Safety Analysis Computer Program
RWMC	Radioactive Waste Management Complex
SAR	Safety Analysis Report
SARA	Superfund Amendments and Reauthorization Act
SDA	Subsurface Disposal Area
SS SSC	safety-significant structure, system, and component
SSC	structure, system, and component
TRU	transuranic
TSA	Transuranic Storage Area
TSDF	Treatment, Storage, and Disposal Facility
TSR	technical safety requirement
WAG	Waste Area Group
WGS	Waste Generator Services

Feasibility Study Preliminary Documented Safety Analysis for In Situ Grouting in the Subsurface Disposal Area

1. SITE CHARACTERISTICS

1.1 Introduction

A description of the site characteristics important to understanding the safety basis of Idaho National Engineering and Environmental Laboratory (INEEL) and Radioactive Waste Management Complex (RWMC) facilities is contained in the INEEL Standardized Safety Analysis Report (SAR) Chapters (SAR-100), Chapter 1, "Site Characteristics,"¹ and in Chapter 1 of the RWMC SAR.² Specific site characteristics that directly affect the design or the hazard and accident analysis for in situ grouting (ISG) at the RWMC are identified in this chapter.

1.2 Requirements

The codes, standards, regulations, and U.S. Department of Energy (DOE) orders and standards pertaining to site characteristics are covered in Chapter 1 of SAR-100. There are no additional requirements that apply uniquely to ISG.

1.3 Site Description

A site description of the INEEL and the RWMC, including pertinent information on geography and demography, is contained in Chapter 1 of SAR-100. Figure 2-1 shows a plot plan of the RWMC. For calculating the potential consequences of postulated accidents to an off-site individual (the public), the distance from the RWMC to the INEEL nearest site boundary (NSB) is 6,000 m to the south.

1.4 Environmental Description

Chapter 1 of SAR-100 contains descriptions of regional and local meteorology, hydrology, and geology. The SAR-100 descriptions of site meteorology, hydrology, and geology also provide the basis for extreme weather conditions found in the natural phenomena threats design of ISG. There are no additional environmental features or requirements unique to ISG.

1.5 Natural Phenomena Threats

Specific natural phenomena threats (hazards) that are potential accident initiators for INEEL facilities are identified in Chapter 1 of SAR-100. See Chapter 3 for details.

1.6 External Manmade Threats

External manmade threats, exclusive of sabotage and terrorism,^a that could be accident initiators for ISG operations are identified and evaluated in Chapter 3 of this Preliminary Documented Safety Analysis (PDSA).

a. The analysis of postulated accidents caused by sabotage and terrorism is not within the scope of the ISG PDSA. Identifying and controlling the risk of potential sabotage and terrorist threats at the RWMC is the responsibility of INEEL and RWMC security.

1.7 Nearby Facilities

Postulated events identified and evaluated in Chapter 3 involving ISG operations could negatively impact nearby RWMC facilities. A radioactive or nonradioactive hazardous material release could require the evacuation of nearby RWMC facilities.

Chapter 1 of SAR-100 describes hazardous operations at nearby INEEL facilities that could adversely impact RWMC facilities. The INEEL facilities located within 15.3 km (9.5 mi) of RWMC are the Central Facilities Area (CFA) and the Idaho Nuclear Technology and Engineering Center (INTEC). No accidents at these facilities have been identified that could adversely impact ISG operations beyond a possible need for evacuation of RWMC.

The Advance Mixed Waste Treatment Project (AMWTP) is located within the boundary of the Transuranic Storage Area (TSA) at the RWMC. The AMWTP is operated for DOE by another contractor. Accidents that would adversely impact ISG operations beyond a possible need for evacuation of RWMC are not anticipated.

1.8 Validity of Existing Environmental Analysis

Chapter 1 of SAR-100 addresses the validity of existing environmental analyses. The site characteristic assumptions contained in this SAR are compatible with those of existing environmental analyses and impact statements (e.g., the Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement).³

1.9 References

1. Idaho National Engineering and Environmental Laboratory, *INEEL Standardized Safety Analysis Report (SAR) Chapters*, Chapter 1, "Site Characteristics," SAR-100, Rev. 0 (hereinafter cited as SAR-100).
2. Thieme, Michael A., 2000, *Radioactive Waste Management Complex Safety Analysis Report*, INEL-1994-0226, Rev. 5, Idaho National Engineering Laboratory, October 2000.
3. DOE-EIS-0203-F, 1995, "DOE Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management Programs Final Environmental Impact Statement," U.S. Department of Energy, April 1995.

2. FACILITY DESCRIPTION

2.1 Introduction

The purpose of in situ grouting (ISG) is to create a solid monolith of the buried waste to prevent subsidence and reduce contamination migration. Contaminant migration may be controlled by reducing water influx through a grouted material, or by chemically or physically binding contaminants within the grouted material. The monolith is created by jet grouting in a relatively tight pattern directly into the soil/waste matrix. Grouting has also been considered as a pretreatment for eventual retrieval of the buried waste. The grout agglomerates fine contaminants such that contamination control during the inherently dusty retrieval operation is performed relatively dust free.

The information presented in this chapter is of sufficient depth and breadth to allow an independent reader to develop an understanding of the structure and operations of the project and perform the hazard analysis in Chapter 3. Information presented in this section includes the following:

- A brief overview of the Subsurface Disposal Area (SDA)
- A description of proposed grouting facilities
- A description of major equipment
- A description of the process and support equipment
- The identification and description of the confinement systems
- The identification and description of the safety-support systems
- The identification and description of the utility and support systems.

The text and figures in this chapter are presented as an aid for the reader and are for descriptive purposes only. Dimensions for equipment and facility features are given as nominal.

2.2 Requirements

The requirements that apply to this facility are found in the following documents:

- 10 Code of Federal Regulation (CFR) 830 Subpart B, “Safety Basis Requirements”
- 10 CFR 835 Subpart K, “Design and Control”
- U.S. Department of Energy (DOE) Order 420.1, “Facility Safety”
- DOE G 421.1-2 Implementation Guide for Use in Developing DSAs to Meet Subpart B of 10 CFR 830
- DOE Order 5480.23, “Nuclear Safety Analysis Reports”
- DOE-ID Architectural Engineering Standards (DOE-ID 2000).

2.3 Facility Overview

The Radioactive Waste Management Complex (RWMC) was established in the early 1950s as a disposal site for solid low-level waste (LLW) generated by operations at the Idaho National Engineering and Environmental Laboratory (INEEL) and other DOE laboratories. Radioactive waste materials were buried in underground pits, trenches, soil vault rows, and one aboveground pad (Pad A) at the SDA. Two types of solid radioactive waste are located in the SDA, transuranic (TRU) waste and LLW. Transuranic waste is radioactive waste that contains alpha-emitting radionuclides with an atomic number greater than 92 (elements heavier than uranium) and a half-life of greater than 20 years. During the period when TRU was buried in the SDA, TRU waste was defined to have an activity concentration greater than 10 nCi/g. Low-level waste is non-TRU waste that contains beta- and gamma-emitting radionuclides. Low-level waste is still being disposed. Transuranic waste from the Rocky Flats Plant (RFP) was disposed in the SDA from 1954 to 1970. After 1970, incoming shipments of TRU waste were placed in interim storage in containers on asphalt pads at the TSA. The RFP, a DOE-owned facility located west of Denver, Colorado, produced components for nuclear weapons.

In August 1987, pursuant to the Resource Conservation and Recovery Act (RCRA) Section 3008(h), the DOE and Environmental Protection Agency (EPA) entered into a Consent Order and Compliance Agreement (COCA). The COCA required DOE to conduct an initial assessment and screening of all solid waste and/or hazardous waste disposal units at the INEEL and to set up a process for conducting any necessary corrective actions. On July 14, 1989, the EPA (under the authority granted to them by the *Comprehensive Environmental Response, Compensation and Liability Act of 1980* [CERCLA] [42 USC § 9601 et seq.], as amended by the *Superfund Amendments and Reauthorization Act of 1986* [SARA]) proposed that INEEL be listed on the National Priorities List (NPL) (54 Federal Register (FR), FR 29820). The final rule that listed the INEEL on the NPL was published on November 21, 1989, in 54 FR 44184. On December 9, 1991, because of the INEEL's listing on the NPL, DOE, EPA, and the Idaho Department of Health and Welfare entered into the Federal Facility Agreement and Consent Order (FFA/CO). Under the FFA/CO, the INEEL is divided into 10 waste area groups (WAGs). These WAGs are further subdivided into operable units (OUs). The RWMC has been designated as WAG 7 and is subdivided into 13 OUs.

The strategy for evaluating buried waste at the INEEL under CERCLA includes the analyses of waste treatment technology options for the remediation of the RWMC. The waste under investigation is buried in the SDA within the RWMC. Figure 2-1 shows the layout of the SDA. The types of remedial alternatives being evaluated for the buried waste include containment, in situ treatment, retrieval and ex situ treatment, and combinations of technologies. The ISG technology is one of the alternative in situ technologies under evaluation and is a possible alternative for remediation of OU 7-13/14.

Early actions are being considered that could be initiated before the enforceable remediation schedule. These are being considered for the non-transuranic areas, including pits 7, 8, and 13–16; trenches 16–58; and soil vault rows 1–21. In situ grouting is being considered as an option for early action.

A promising combination of treatments consists of combining an in situ thermal desorption (ISTD) pretreatment followed by in situ grouting (ISG). In situ thermal desorption is a soil remediation process in which heat and vacuum are applied to subsurface-contaminated media. Pits 4, 5, 6, and 10 are being considered for treatment. They contain organic sludges, nitrate sludges, combustible solids, and graphite wastes, all of which are contaminated with plutonium. These wastes were disposed of in standard 55-gal drums. It is anticipated these drums have corroded and contaminated the 2 ft of soil underburden, all interstitial soil, and the bottom 1 ft of the soil overburden. The objective of ISTD remediation is to

remove or destroy these nonradioactive contaminants. Heat flows into the contaminated media by conduction from buried heaters operated at 1,292–1,472°F. These high temperatures remove and destroy organic and nitrate contaminants of concern (COCs). The vaporized constituents are drawn by vacuum into an off-gas treatment system that removes remaining contaminants. In situ grouting would be applied after ISTD to stabilize the subsurface area and fill in voids created by destruction of waste materials.

The SDA encompasses 97 acres of land on the western portion of the RWMC. The area includes Pad A, trenches, pits, and vaults that have been used for disposal. Currently, only pits 17–20 and concrete-lined vaults are used to dispose of LLW. Dikes and drainage channels are appropriately located to channel water away from the SDA to prevent flooding. Grouting is being considered for the pits and trenches containing TRU waste, the pits and trenches containing LLW, and the LLW soil vaults. Waste on Pad A may be removed for stabilization and subsequent disposal within the SDA. Remediation activities for OU 7-10 (known as Pit 9) are conducted at the SDA, but are not within the scope of this document.

2.3.1 Pits and Trenches

There are 20 disposal pits and 58 trenches within the SDA. The pits and trenches are defined as TRU or non-TRU, depending on the contents. Waste has been disposed in drums, cardboard boxes, wood boxes, metal boxes, and other containers. Most containers are breached. The types of waste, and the radioactive and nonradioactive hazardous source terms, are described in Chapter 3.

The trenches are approximately 10 ft wide, 900 ft long, and an average of 13 ft deep. Some trenches were excavated to the underlying basalt. In the late 1960s, the minimum trench depth increased from 3 ft to 5 ft, the bottoms of excavations were lined with at least 2 ft of soil under burden, waste was compacted by dropping a heavy steel plate on the waste in some trenches, and the soil cover was increased from a minimum of 2 ft to 3 ft. Adjacent trench centerlines were separated by no more than 16 ft. When the trenches were full, they were covered with a minimum of 2–3 ft of soil.

Pits are 100 ft wide, 13–32 ft deep, and vary in length from 200–1,200 ft. A soil underburden, at least 2 ft thick, was used to cover basalt before waste was emplaced. A final layer of compacted soil, at least 3 ft thick, was used to cover buried waste. Current pits are excavated into rock to a depth of 30 ft, then backfilled with at least 3 ft of soil.

Trenches were used for both contact-handled and remote-handled radioactive waste. From 1952 to 1957, the waste was buried only in trenches.

Waste with high-radiation levels was handled remotely using specially shielded containers and boom cranes. As waste disposal became more rigorously controlled, the trenches were used more frequently for high-radiation waste until they were replaced by soil vaults. For some trenches, metal liners were placed over the trench as it was filled. The metal liners prevented the trench from sloughing off and provided shielding.

Beginning in 1957, the larger open pits were excavated for disposing large, bulky items. Initially, waste was stacked horizontally in pits. From 1963 until 1969, drums from RFP were dumped into pits, rather than stacked, to reduce labor costs and personnel exposure.

The burial of most nonradioactive hazardous material mixed wastes was terminated in 1982. Thus, pits and trenches filled after that time are not expected to contain significant quantities of nonradioactive hazardous materials.

2.3.1.1 TRU Pits and Trenches. The TRU pits and trenches are those that operated between 1952 and 1970, when both non-TRU and TRU waste were buried at the SDA. Waste from onsite generators was primarily non-TRU. From 1960 until 1963, non-TRU waste was also accepted from AEC licensed private entities. Transuranic waste was received from RFP and other generators beginning in 1954. Burial of TRU waste was discontinued in 1970. Much of this waste also contained nonradioactive hazardous material. Pits 1–6 and 9–12 and trenches 1–10 are known to contain TRU waste. Trenches 11–15 are suspected to contain TRU waste. The remaining pits (7, 8, 13–20) and trenches (16–58) contain only non-TRU. Rocky Flats Plant waste in drums and boxes was disposed in Pits 11 and 12 through 1972, but the drums were retrieved and the TRU drums placed on the Transuranic Storage Area pads. The boxes were left in Pits 11 and 12 and could contain TRU waste.

2.3.1.2 Non-TRU Pits and Trenches. Pits and trenches containing only non-TRU waste have been used since 1970. The same types of non-TRU waste continued to be disposed after 1970, but disposal practices improved over time. The use of trenches was terminated in 1982. Waste is currently disposed of only in pits and concrete vaults. Compaction, restrictive packaging criteria, and enlarged pit volumes were employed to improve space utilization. Close-packed array stacking was employed in the pits. Pits were expanded by using heavy equipment and explosive fracturing to remove fractured basalt from the base of the pits. A soil underburden at least 2 ft thick was used to cover basalt before waste was emplaced. A final layer of compacted soil at least 3 ft thick was used to cover buried waste. In 1985, a geotextile liner was incorporated into the upper portion of the pit floor soil cover to add stability to the waste stack and support mobile equipment. In recent years the waste has been carefully stacked.

2.3.1.3 Subsidence. Subsidence occurs frequently in the SDA. Most subsidence occurs in the spring. Subsidence is expected to continue unless measures to eliminate void spaces in the waste zone are implemented. Between 1996 and 2001 the number of occurrences ranged from five, in 2001, to 17 in 1998. Some areas of subsidence have been long and narrow, and some almost square. Depths ranged from 3 in. to 12 ft. Subsidence areas are repaired by filling holes with soil obtained from the spreading areas. Soil is hauled to the area, dumped close to the subsidence, and pushed into the hole with a front-end loader. The soil is compacted by hand or by driving a front-end loader over the filled area. During spring thaw, vehicles are prohibited from driving over waste disposal areas in the SDA. Radiation levels were measured below 100 cpm for each occurrence, except in April 2001, when 1,000 cpm was measured at Pit 4.

Areas pretreated with ISTD may be more susceptible to subsidence because the process destroys or removes portions of the waste matrix, increasing the amount of void space. The increased potential for these voids to subside can be mitigated by placing 10 ft of overburden soil above the waste zones prior to ISTD processing.

2.3.2 Soil Vaults

Soil vaults were used to dispose of RH-LLW, which is solid, non-TRU waste having exposure rates higher than 500 mR/hr at 1 m. They were used between 1977 and 1995. This waste was typically in a steel container. To conserve space, a change was made to concrete vaults (vaults that have a concrete liner). Soil vaults, but not concrete vaults, are being considered for ISG. The soil vaults are positioned in rows adjacent to pits and trenches throughout the SDA.

The soil vaults were unlined holes of 1.3–6.5 ft diameter bored to bedrock in rows. Depths vary from 17–25 ft. Individual vaults are at least 2 ft apart. The holes were backfilled with 2 ft of soil to create a base, and filled to a depth that allowed a minimum of 3 ft of soil over the top waste container. The amount of soil cover was calculated and compared to available soil vault depth before each discharge.

Additional soil was added when necessary to reduce exposure rate above the covered vault to less than 1 mR/hour at the soil surface.

Soil vault rows are distributed throughout the SDA adjacent to pits and trenches. Concrete monuments identify the soil vault locations. A brass plate on each monument is stamped with the vault number and opening and closing date. Periodic inspection and maintenance is conducted to ensure that soil vaults have at least 1.8 m (6 ft) of cover.

2.3.3 Pad A

Pad A was constructed in 1972 as the Transuranic Disposal Area. Disposal operations were conducted on Pad A from 1972 to 1978. It is located in the north central part of the SDA that was not suited for pits or trenches because of basalt near the surface. Pad A is 243 ft wide × 328 ft long and is constructed of a 3-in asphalt surface over a 4-in gravel base. Pad A contains TRU alpha-emitting radioisotopes with concentrations less than or equal to 100 nCi/g, but greater than 10 nCi/g, and exposure rates less than 200 mR/hr at the container surface. Also there are a small number of TRU drums on Pad A. The waste on Pad A has been completely covered with soil. For this document, it is assumed the waste on Pad A will be removed for stabilization and subsequent disposal within the SDA and will not be grouted in its current location.

2.4 Facility Structure

This FS-PDSA uses design and process information available February 2003. Additional information on facility design will be provided in the preliminary documented safety analysis (PDSA). The major project facilities involved in the ISG process are the Mobile Containment Structure (MCS) and the grout supply facilities. Several MCS units may operate simultaneously in the SDA.

2.4.1 Mobile Containment Structure

The MCS consists of a rigid, rectangular platform substructure and a flexible, steel-framed superstructure (see Figure 2-2). The outer dimensions of the substructure are approximately 45 × 42 ft with an 18-ft square opening through which the grouting operation takes place. The substructure consists of braced steel structural shapes and floor plate to provide rigidity. The steel framed superstructure is completely covered by a polyester cover that is tensioned over the frame to provide a tight-fitting shell. Crane runway beams are integrated into the substructure on two sides of the opening. The height of each MCS unit will vary depending on the height of the drill rig mast the MCS encloses. Unit heights are expected to range from 30 to 45 ft.

A crawler track assembly (approximately 4 ft high) with an electric drive motor is mounted to the underside of each of the four corners of the platform and moves the MCS into place above each grouting area. The crawler tracks are sized to produce a pressure on the soil of no more than 500 psf. These crawler assemblies are outfitted with hydraulic cylinders that level the structure after each move. The hydraulic leveling system may also be used for recovery from a subsidence event. The structure must be leveled after each move to prevent detrimental vertical deflection of the runway rails and bridge during drilling operations.

Grout containment sheet piling will be inserted into the soil before the MCS is moved into position to create a berm for containment of any grout returns (see Figure 2-5). Grout returns are the quantities of grout that return to the surface after being injected into the ground.

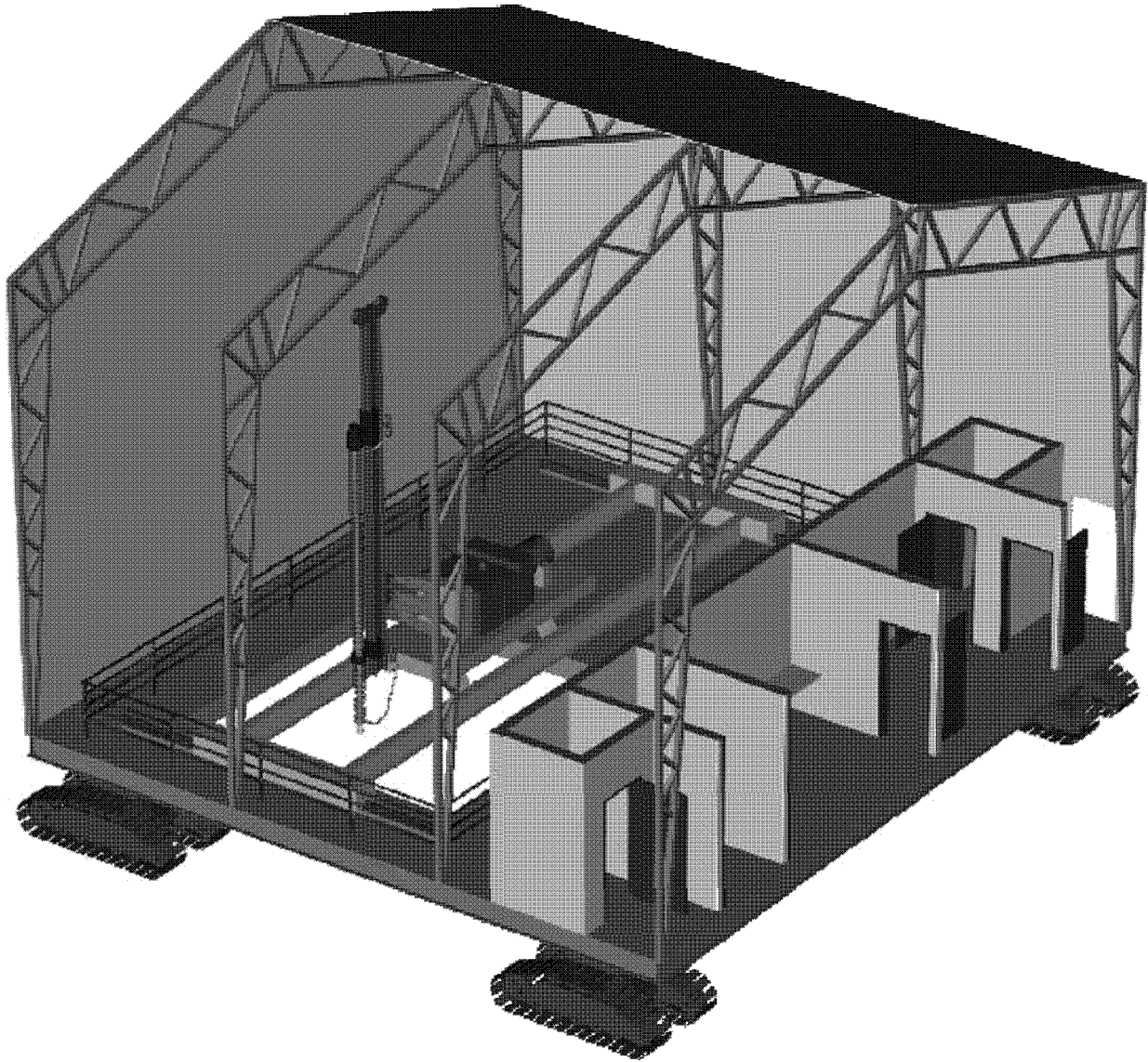


Figure 2-2. The ISG Mobile Containment Structure (MCS).

In addition to normal building loads, the MCS and all structures and equipment interior to the MCS will be designed to meet natural phenomena loading criteria (seismic loading for all structures, systems, and wind loading where applicable) for a Performance Category 2 facility, as defined by the DOE-ID Architectural Engineering Standards.

The interior of the MCS houses the following:

- Bridge crane
- Drill rig
- Drill shroud
- Operating gallery

- Maintenance glovebox
- Change room and airlock
- Access walkway
- Electrical Room
- MCS to Ground Containment Barrier.

Each of the components, systems, and areas are described in the sections that follow.

2.4.1.1 Bridge Crane. The crane is a top-running bridge crane. The drill rig is mounted on top of the trolley. The trolley is designed to run along the bottom flange of the bridge in order to place the drill rig closer to the soil surface. The bridge girder end trucks are outfitted to provide x, z positioning for the end truck subassembly of the bridge crane. Bridge crane end truck brakes and trolley brakes are applied prior to each move. The crane uses enclosed-type current conductors or festoon-type cabling for electricity. The bridge crane will be designed in accordance with applicable portions of CMAA-70, Specifications for Top Running Bridge & Gantry Type Multiple Girder Electric Overhead Traveling Cranes, DOE-ID Architectural Engineering Standard, Section 1460, Cranes and Hoists, DOE STD-1090 and 29 CFR1910 Subpart N.

2.4.1.2 Drill Rig. The drill rig (see Figure 2-3) is a roto-percussion type jet-grouting rig powered by an electric motor with electric over hydraulic remote controls. The rig is mounted on top of and moves with the trolley. The rig is capable of drilling through the soil waste matrix using a 3 and 9/16 in. diameter-rotating cone bit at a rate of 10 ft/min. The drill steel and bit are rotated as a single rigid unit by a hydraulic-powered drill motor. Simultaneous with the rotation, a hammering action is transmitted through the drill steel into the bit. The bit is driven through the soil/waste matrix until refusal (normally at basalt). No drill cuttings will be produced. Adding or removing drill steel is not anticipated during a drill/grouting cycle. The rig will be designed with a mast high enough for the drill steel to pass through the soil/waste matrix to basalt in a single stroke. Safety shields around the accessible connections for high-pressure hydraulic hoses and piping during operations are required, as recommended in lessons learned from previous drilling operations.

Instrumentation providing graphical real time x, y, z positioning and jet-grouting parameters relative to the ground surface will be provided with the drill rig. These parameters include depth, penetration rate, thrust and circulation pressure, rotation torque, flows, and mast inclination. Other parameters relative to the grouting sequence include drill string rotational rate in RPM, step size, and dwell time on each step. The parameters will be recorded on a memory card and can be downloaded to any PC using software provided by the instrumentation vendor.

In the interest of safety, the drill rig will include: an automatic system relief valve, a remotely controlled bleed valve, a manually operated bleed valve and an automatic pump clutch. Accessible high-pressure hoses and equipment will be shielded with safety shields during testing and maintenance operations.

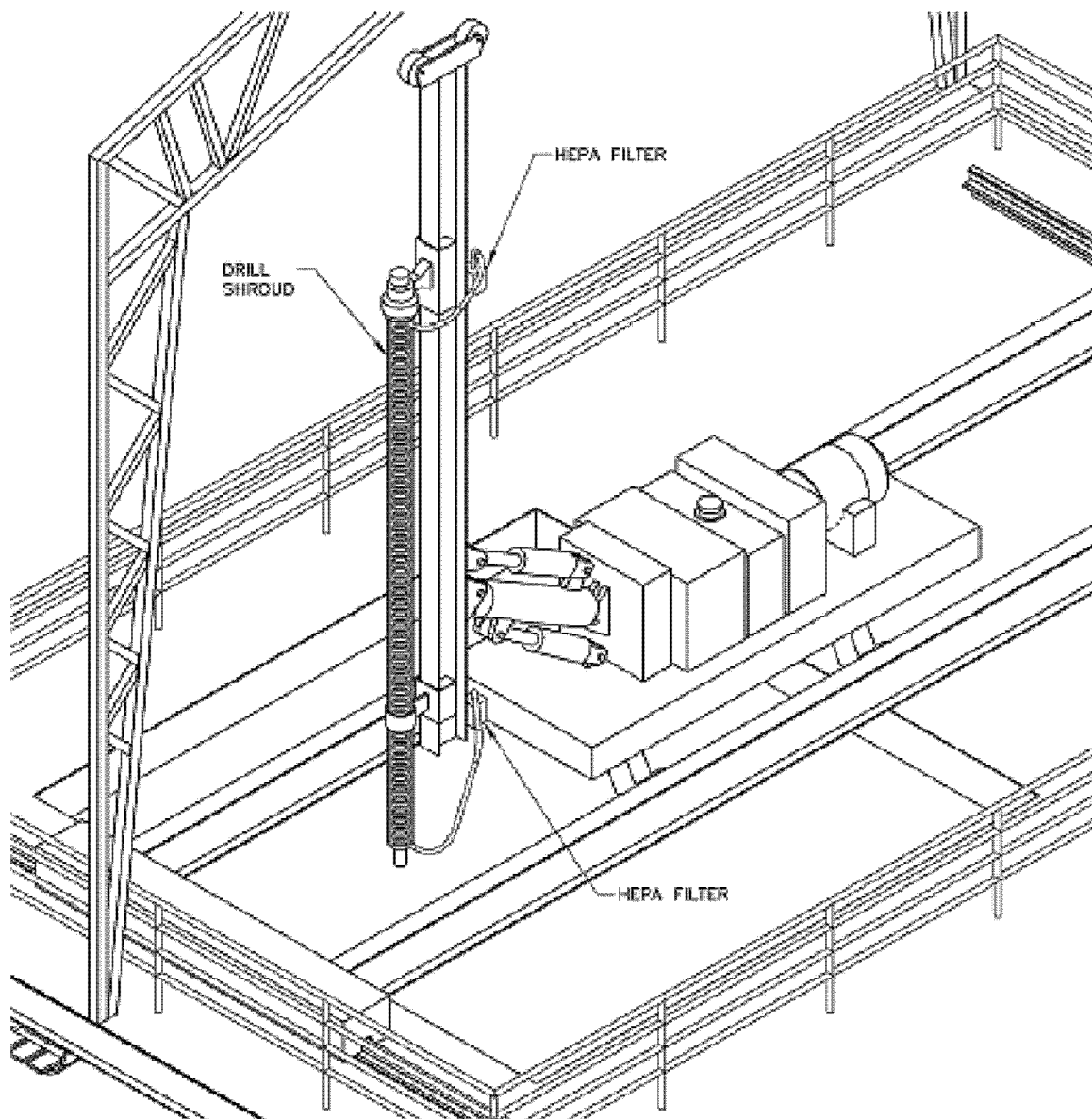


Figure 2-3. The ISG delivery system drill rig.

2.4.1.3 Drill Shroud. The drill shroud is designed to provide a high-efficiency particulate air (HEPA)-filtered flexible containment around the rotating drill steel during the grouting process. The bottom of the shroud has a wiper system, which wipes grout from the drill steel as it is withdrawn from the grout hole.

The drill shroud consists of a cylinder housing located at the top of the drill steel attached to a flexible liner that will seal against the drill steel. The wiper system and another cylinder housing attached to the liner shroud are located at the bottom of the drill steel. The space between the drill steel and the liner are vented by a passive HEPA filtration system. The drill steel breakout point is between the drive motor and upper cylinder, this allows the drill stem and shroud to be removed for decontamination or replacement.

2.4.1.4 Operating Gallery. The operating gallery is an enclosure within the MCS where workers remotely control and monitor the grouting operation, crane operation, ventilation, and other functions. The gallery has windows to allow a direct view of most of the MCS interior, but many operational views and views of key equipment will be available over closed circuit television monitors. Data logging equipment for recording the drill rig parameters (see Section 2.4.1.2) are also housed within the operating gallery.

2.4.1.5 Maintenance Glovebox. A glovebox will be used for maintaining and cleaning the drill stem grouting subassembly and replacing the rotating cone bit. The glovebox is outfitted with hydraulically-operated breakout tools, water collection pan, water flush manifold, water sprayer, waste bag out port, drill stem access port, and lighting. The glovebox is constructed of a steel frame, stainless steel bottom collection pan with drain, Lexan panels, glove ports with gloves and safety covers, a drill stem holding jig, and HEPA filter inlets.

The glovebox exhaust blower design will produce inward airflow into glovebox ports (with one glove removed) of at least 125 fpm. Exhaust is filtered by HEPA filters. The water collection pan will drain to a portable holding tank located outside of the glovebox. Water will be sampled and analyzed before disposal.

2.4.1.6 Electrical Room. The electrical room houses the motor control center, control panels, disconnect switches, and necessary junction boxes. There are no hydraulic lines or other piping in this room.

2.4.1.7 Change Room and Airlock. An access airlock for personnel and small pieces of equipment will be placed adjacent to both the exterior of the MCS and to the operating gallery, allowing controlled access to the facility. A change room is located next to the airlock.

2.4.1.8 Access Walkway. A walkway approximately 4 ft wide with standard guard railing will be provided all around the opening in the substructure to facilitate maintenance of the crane, drill rig, hydraulic controls, and MCS track assemblies.

2.4.1.9 Ventilation System. The HVAC system for the MCS consists of five subsystems:

- A conventional heating, ventilation, and air conditioning (HVAC) system using a heat pump with an auxiliary heater provides a comfortable work environment for the workers in the control room/operating gallery and change room. The HVAC system is a once through system without recirculation. Ventilation outside air requirements shall be a minimum of 20 cfm/person expected in the occupied space as recommended for laboratories by ASHRAE Standard 62, *Ventilation for Acceptable Indoor Air Quality*, or more if required for the heat load. The HVAC system will be designed in accordance with DOE-ID Architectural Engineering Standard Section 1550, *Heating and Ventilation*.
- A heated weather enclosure is provided for the grout pump and equipment located outside of the MCS during winter to keep the equipment from freezing.
- The MCS main structure ventilation will be designed for contamination control in accordance with ERDA 76-21, *Nuclear Clean Air Handbook*. Inlet air for the MCS structure flows through a counterbalanced back-draft damper and roughing filter in the structure wall. The back-draft damper is adjusted to maintain the structure interior static air pressure at -0.25 cm (-0.1 in.) water gauge with respect to outside ambient pressure. Inlet air will also flow from the airlock (when open) into the structure interior. Exhaust air will be filtered through HEPA filters as shown in Figure 2-4. Unit heaters will provide freeze protection for the main enclosure during winter.

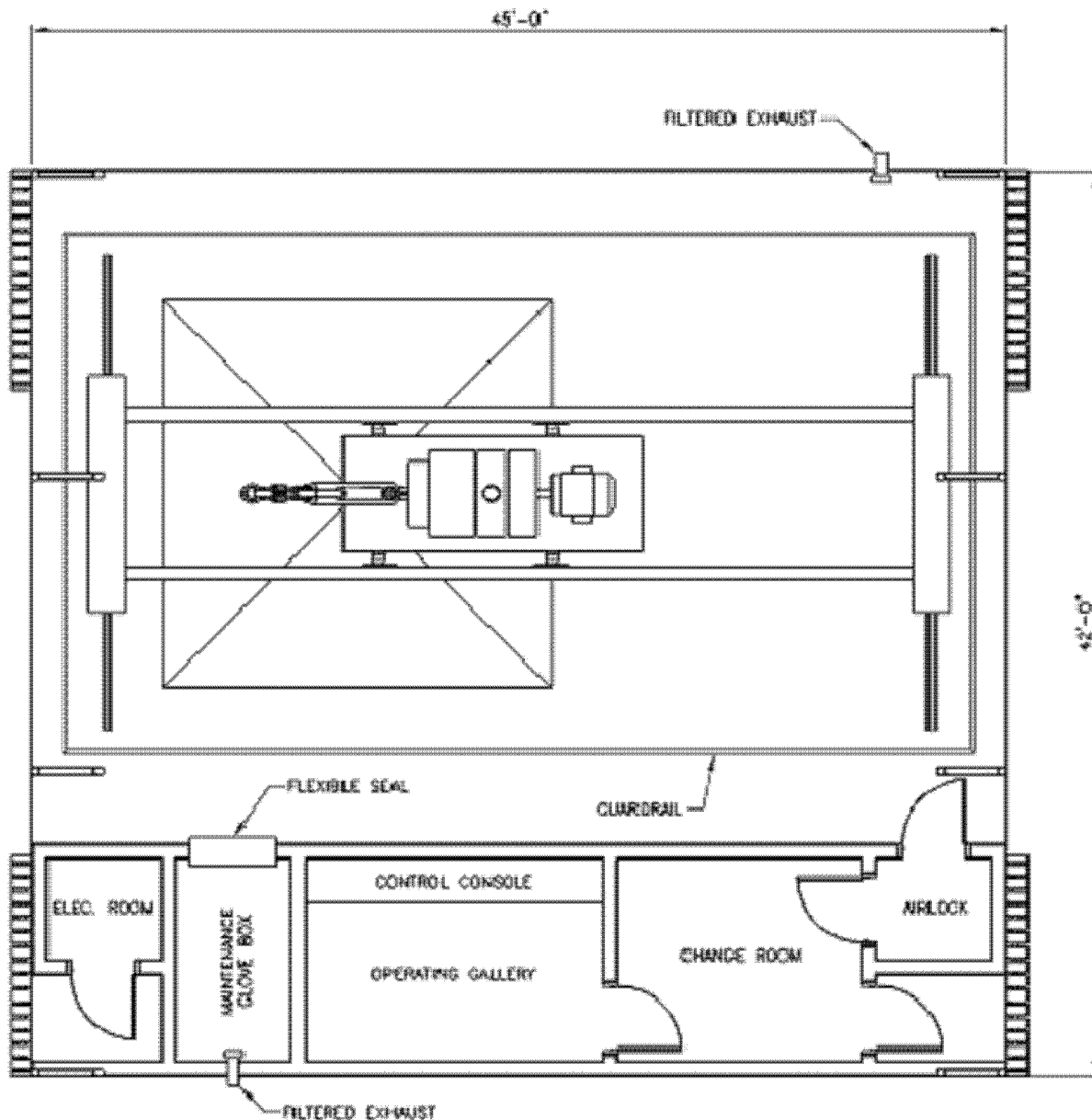


Figure 2-4. Floor plan of the MCS.

- An exhaust blower provides ventilation within the glovebox by producing inward airflow into the glovebox ports (with one glove removed) of at least 125fpm. The air will be HEPA-filtered then exhausted outside.

The drill string shroud is a passive ventilation system, which exhausts when the shroud is compressed during drilling. The shroud exhausts through a HEPA filter back to the MCS interior.

2.4.1.10 MCS to Ground Containment Barrier. A hydraulic system mounted to the inside edge of the substructure opening raises and lowers a thin, rigid barrier for complete secondary containment. When the barrier is raised, the MCS may move to a new grouting area (see Figure 2-5). When the barrier is lowered, it penetrates the soil slightly and closes off the space between the ground surface and the bottom of the opening in the substructure.

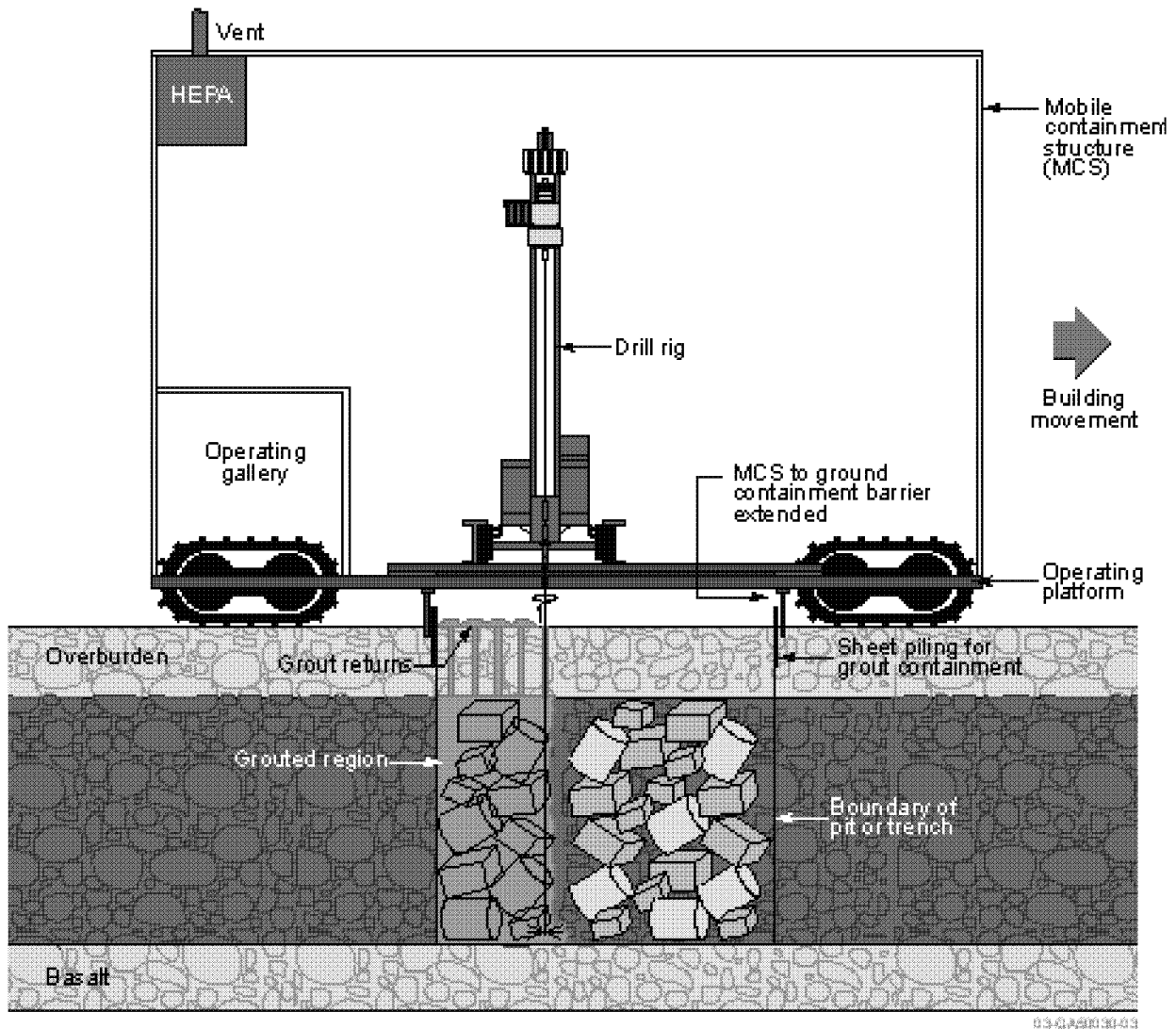


Figure 2-5. ISG delivery system in jet grouting mode.

2.4.2 Grout Supply Facilities

The grouting facilities and equipment include:

- Silos
- Batch plant
- Delivery trucks
- Grout-receiving hopper
- Agitator
- High-pressure pump

- High-pressure flexible lines
- Drill stem
- Rotating cone bit.

The grouting system must be capable of injecting 30 gallons per minute into the soil matrix. The system will be designed for ease of cleaning grout injection nozzles using a water flush manifold in the glovebox.

The batch plant will be located outside of the SDA boundaries and trucks will deliver the mixed grout from the batch plant to the grout-receiving hopper. The grout-receiving hopper, agitator, and grout pump will be located on a vehicle that will be adjacent to the MCS. When required, this vehicle will move with the MCS to each treatment area. Silos for storing dry components will be located alongside the batch plant. Dry components will feed into the batch plant colloidal mixer by screw conveyors. Water will be added to the mixer and when mixing is complete, the grout will be transferred into a holding tank and from the holding tank into the delivery trucks. Batch plant capacity will be approximately 7 yd³/hr for each drill rig in operation. The grout-receiving hopper will feed into an agitator and into the grout pump through low-pressure lines. High-pressure flexible grout lines will lead from the grout pump to the drill rig mounted on the trolley and will feed grout to the drill stem and rotating cone bit. Flexible high-pressure lines within the MCS will be completely isolated from operators when pressurized. The cone bit injects the grout into the soil waste matrix as the drill stem is raised. The drill stem grouting nozzle subassembly will be removable and replaced and/or cleaned in the glovebox using uncontaminated water.

Another grout line mounted on the trolley, independent of the drill stem, will be capable of depositing a low-density 2-in.-thick grout cover over the grout returns.

Recommendations resulting from a high-pressure system failure during testing at the RWMC will be incorporated in the design. These include:

- Designed for the maximum grout pump pressure
- High-pressure relief valve and redundant pressure relief plug
- Pressure-actuated automatic pump clutch trip out switch
- Pressure-rated fittings such as valves, hoses, and tie-downs
- Blast shield around the high-pressure pump outlet.

2.5 Process Description

2.5.1 Introduction

The ISG delivery system drills directly into the buried waste and injects grout to form a solid block of soil, waste, and injected grout. Sheet piling embedded in the soil creates a grout containment berm around the surface of the area to contain any grout returns and provide an ideal area for a top cap.

The amount of grout return that comes to the surface during the drilling operation varies depending on the waste material. The ISG delivery system is being developed to manage this grout return.

The remainder of this section describes the process used for the ISG delivery system, including the general concept behind the system, site preparation, construction, testing, normal and abnormal operating procedures, emergency operating procedures, and decontamination and decommissioning of the system.

2.5.2 General Concept

The purpose of ISG is to contain the waste buried at the SDA and create a surface area for future capping operations. This goal is accomplished by drilling holes into the waste and injecting grout on an approximate 20-in. triangular pitch matrix. The injected grout creates a series of interconnected columns that form a solid monolith of soil, waste, and grout. Several systems may be operating simultaneously in the SDA.

The drilling process is controlled remotely from the operating gallery within the MCS. Roto-percussion and a rotating drill string are used to penetrate the waste. Once the drill stem is inserted to the basalt/soil interface below the waste seam, grout is injected using at least two nozzles (2.4-3 mm in diameter depending upon grout type) located 180 degrees apart on the bottom of the drill stem (see Figure-2-5). The drill string is then withdrawn in discrete, predetermined increments called steps. The amount of time spent on any given step, and the rotation of the drill steel, varies depending upon waste/soil type. The minimum amount of rotation is two complete revolutions per step. Grouting is stopped at the top of the waste material leaving at least a 3-foot barrier of ungrouted overburden material.

The drill rig operates on a platform. Beneath the platform, preplaced grout containment sheet piling is embedded in the overburden to create a berm for the grouted area. This berm stops any grout returns that come to the surface from spilling into unwanted areas. The amount of grout return varies depending on the waste material. The sheet piling is left in place permanently, further reducing the potential for contamination spread. When grouting in soil with low void volume, a large return of grout mixed with soil comes to the surface. However, when grouting buried debris containing large voids, the return is minimal. Once an area is grouted, it is stabilized for contamination spread by covering the area with a cap of grout and covering the cap with soil (see Figure 2-6). The MCS is then moved to the next location and the process is repeated.

The ISG delivery system works on pits, trenches and soil vaults. Because the pits are irregularly-shaped polygons with relatively long runs of straight edges, the system moves in a straight line as if it were plowing a field (see Figures 2-7 and 2-8). When it comes to the edge of a pit, the system reverses direction, moves laterally, and begins grouting another straight line. Conversely, the trenches and soil vaults are long straight runs of more or less parallel rows approximately 3–6 ft wide and up to hundreds of feet long. The soil vaults and trenches are ideally situated for the ISG delivery system because the system traverses up to eight long rows of material at a time.

2.5.3 Site Preparation

In preparation for grouting, each area will be leveled. Leveling will be accomplished by adding compacted fill of INEEL lakebed soil or equivalent. After leveling, the sheet piling for grout containment is preplaced in preparation for the grouting operation. The system will be moved on a daily basis. There will be a continuous leveling operation ahead of the grouting operation.

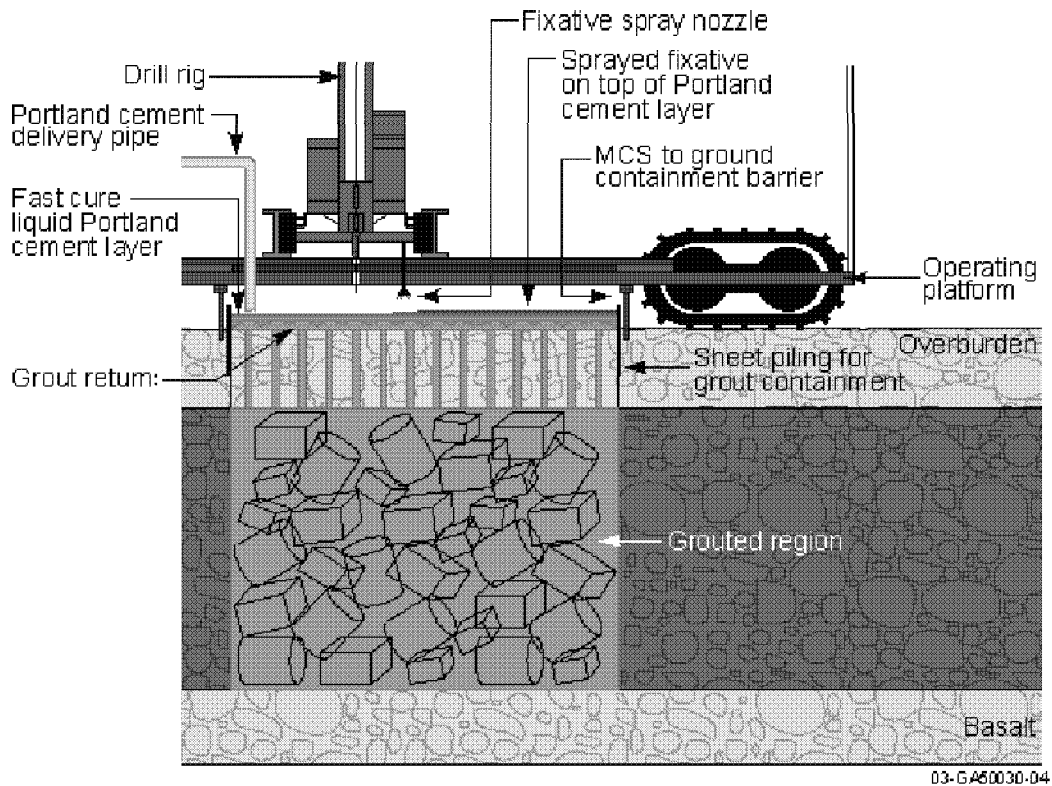


Figure 2-6. Preparing top surface prior to moving.

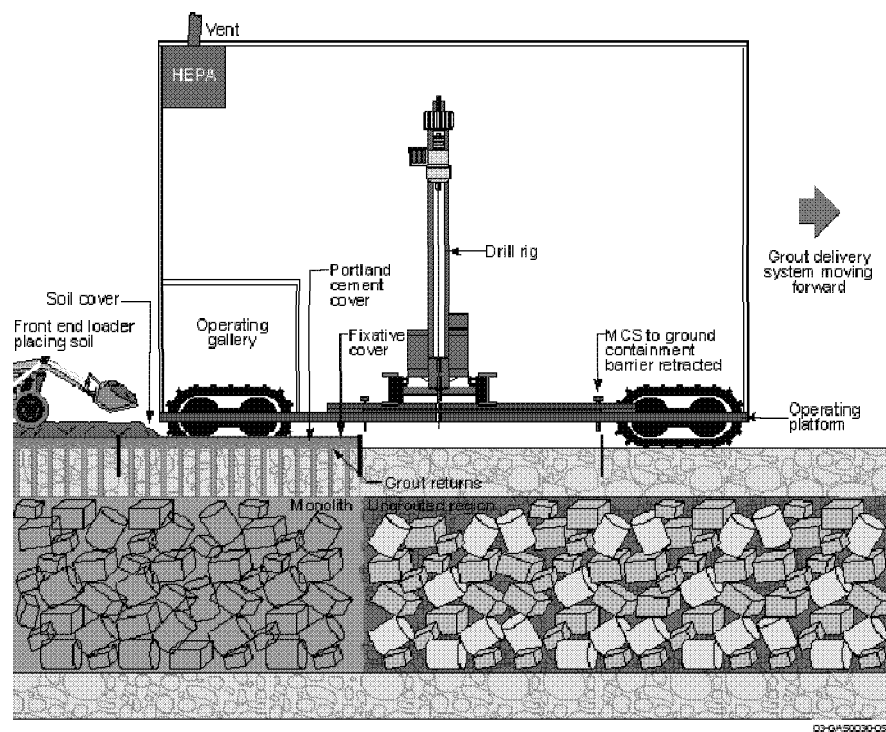


Figure 2-7. Moving the system to the next location (side view).

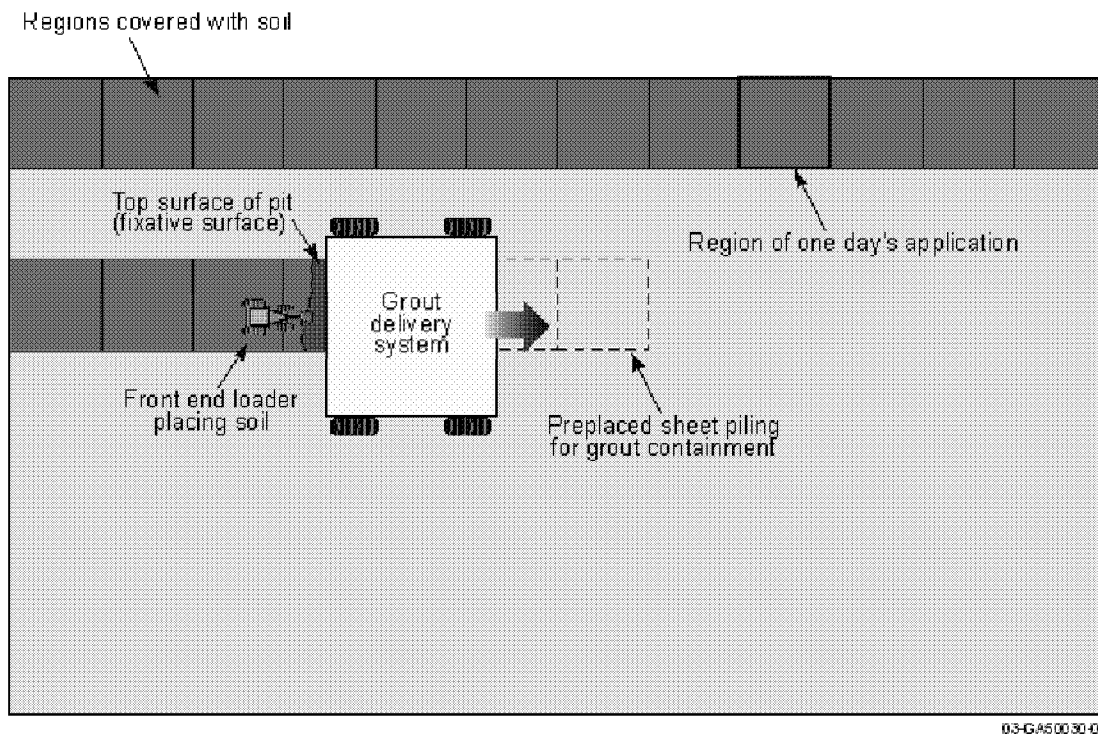


Figure 2-8. Moving the system to the next location (top view).

2.5.3.1 Grout. There are two types of grout that may be used for the subsurface grouting: cementitious and hydrocarbon-based grouts. Examples of cementitious grouts that have been shown to be jet groutable in past INEEL demonstrations include Portland type 1/2 mixed 1:1 water by mass, Portland type H mixed 1:1 water by mass, TECT-HG, GMENT-12, and US GROUT. The only hydrocarbon-based grout that has been demonstrated is called WAXFIX. WAXFIX is thermoplastic paraffin that melts at 120–140°F and then sets upon cooling. In general, the cementitious grouts will require delivery of dry ingredients and mixing in the batch plant. The WAXFIX grout will be delivered in heated tanker trucks or trains in a molten form.

2.5.3.1.1 Cementitious Grout—Cementitious grout returns when grouting buried debris are low (approximately 1 gal per hole), but can become high (up to 5 gal per hole) when injecting directly into soil regions. Higher-density grouts such as TECT-HG and GMENT-12 have smaller grout returns, while lower-density grouts, such as US grout and the Portland grouts, tend to have larger grout returns. Even though the amount of returning grout varies within the cementitious grouts, the cementitious grouts generally have returns less than 5 gal per hole for all grouts considered.

Injection of the cementitious grouts requires great care in maintaining a clean, debris-free grout delivery system. Small pieces of grout or impurities (such as small pieces of rock) can block small 2–3 mm injection nozzles. As part of the ISG process, the need to keep the grout agitated by continuous movement is also important in that a process of filter caking can also lead to blockage of the nozzles. To accomplish this, a bypass flow line can be utilized at the grout delivery hopper to keep the grout flowing. A small trickle flow of grout through the nozzles can also avoid nozzle blockage when moving the system from one position to another.

Cementitious grouts must be cleaned out of the interior equipment of the grout delivery system (the pumps, lines, and drill steel) after each day's grouting is completed. This involves pumping at least 200 gal of clean water through the interior of the system. This can be accomplished without creating a

secondary waste by removing the injection nozzle subassembly (drill bit and nozzle) in a glovebox and attaching a manifold leading to a clean-out water collection tank. Clean water can be introduced into the pumping equipment and simply pumped through the system.

2.5.3.1.2 Capping Grout—The grout used to seal the grout returns is a Portland type 1/2 grout with an approximate mix of 1:1 by mass water. This material caps the grout returns by creating a pool of grout that covers the highest return. The capping operation is controlled using a remote camera system. A special setting agent is added to the grout causing the grout to set in approximately 2 hours. Once the grout has set, a special fixative material is sprayed on top of the grout to further encapsulate any radioactive particulate that has risen to the surface during the pouring action. This material is also a fast curing material that allows the grout delivery system to be moved a few hours after pouring the grout cap and the fixative cover.

2.5.3.1.3 Paraffin—If the relatively lightweight WAXFIX grout is injected into the subsurface waste, up to 40% by volume of what is injected can be expected to come to the surface. At the surface, a pool of mostly molten neat grout is formed. As the subsurface WAXFIX penetrates by permeation into the various waste materials and soils, the pool above acts as a reservoir to supply additional material to positions below. The return pool of WAXFIX grout may stay molten for up to 5 days after grouting; however, there will be a solid film of cooled wax on the surface of the pool virtually overnight. When using the WAXFIX grout, the need for a Portland pour and fixative on the top surface is unnecessary because of the liquid nature of the pool and the fact that the cooled surface tends to hold solid particulate in place in the wax film. It is anticipated that the soil cover on the recently grouted region can be placed immediately after the grout delivery system is moved.

Maintaining a trickle flow of WAXFIX grout through the system keeps the nozzle from plugging. Additional heat tracing in the grout delivery system may be required, especially when operating in a cold climate, to ensure that the WAXFIX does not cool and solidify in the lines.

Flowing a few hundred gallons of hot (140–160°F) water through the system removes any excess WAXFIX.

2.5.3.2 Pretreated Areas. Areas that have been pretreated with ISTD will not require any special preparations. The treated areas are estimated to encompass approximately 2.6 acres. They will be contoured to create a smooth working surface; however, the subsurface conditions will be different because there will be a soil overburden at least 10 ft deep. In situ thermal desorption may make the treated soil more porous by heating and driving off water. Also, there will be buried equipment used to implement ISTD. Buried heater wells will be arranged in a hexagonal pattern around vacuum/heater wells. The heater wells will be 7 ft apart with vacuum/heater wells in the middle of the hexagonal pattern. The vacuum/heater wells will be 12.12 ft apart. Each of several 0.27-acre module areas will be approximately 122 × 97 ft and contain 96 vacuum/heater wells and 216 heater wells connected with header piping. The piping will have been pumped full of grout to stabilize the piping and immobilize residual contamination.¹

2.5.4 Construction of System

The ISG delivery system will be manufactured off-site and delivered to the INEEL SDA in components. The components will be constructed over the position of the first application after cold testing. The HEPA filtration system and all functions of the newly constructed system will be System Operation (SO)-tested in place prior to use. The exterior ancillary systems, including the electrical and high-pressure pumping equipment, will then be connected to the delivery system and tested for

performance. A complete set of exchange parts will be on-site to completely reassemble the drilling/pumping equipment in a 2-day period, in the event of a major breakdown.

Electrical power to the hydraulic drive system will be connected prior to testing the delivery systems. The power for the electrical system will be either an ancillary diesel generator set or the existing power grid for the SDA.

A grout batch plant will be constructed just off the SDA. The batch plant, which will be located in either the Cold Test Pit South Area or the Cold Test Pit North Area, will deliver grout continuously to the delivery system. Multiple grout delivery trucks will be staged for use between the delivery system and the batch plant. Special routing of roads will be prearranged for this travel. It is anticipated that the existing rail spur will be utilized to deliver large tonnage of dry grout ingredients and that an all-weather water supply system will be supplied at the batch plant. In addition, multiple mobile grout clean-out tanks will be staged next to the grout delivery system. Clean-out water lay-down areas will be supplied in the area of the batch plant.

2.5.5 SO Testing

All phases of the grouting operation will be tested in an area out of the waste, but at the RWMC. These include:

- Platform mobility
- XYZ/grout volume Data Acquisition system
- Drilling/grouting
- Change-out of subassembly in glovebox system adjacent to the delivery system
- Nozzle clean-out in glovebox system adjacent to the delivery system
- System clean-out
- Manned entry for drill string removal (in the case of a stuck drill string in a refusal situation)
- All remote camera systems
- The criticality alarm (for TRU pits and trenches)
- All other Rad-Con monitoring systems
- Ventilation system operation
- Batch plant operations
- System clean-out and system move
- Subsidence event mitigation.

2.5.6 Conceptual Detailed Operating Procedures

2.5.6.1 Normal Operations. The ISG delivery system is placed in the ready position over the starting point on a pit or trench by surveying the corners of the MCS. High-pressure hoses and electrical connections are in place and the MCS is sealed. The ventilation negative pressure HEPA filtration system is started. The positioning system is calibrated to allow total local xyz control of the nozzles in the drill string (the drill string mast is leveled in two dimensions vertically). The volume flow and pressure measurement systems are calibrated.

Simultaneously to these preliminary operations, the grout batch plant prepares to produce an amount of grout equal to the day's rate of use. Each rig applying grout in the SDA should consume 600 gal of grout per hour of operation.

Grout is delivered to the external grout hopper and the low-pressure grout delivery pump is engaged, allowing a recirculation of the grout in the hopper up to the high-pressure pump inlet and out through the nozzles (trickle flow out the nozzles is established). Once it is verified by remote camera that the extra water in the high-pressure lines has been replaced by grout (visual observation of the trickle flow), the grouting operation is considered to be in the ready position.

Drilling takes place at a predetermined rotational rate as the drill string is lowered through the waste to the basalt by Roto-percussion. Once the drill string reaches the basalt, the high-pressure pump is engaged and the pressure is brought up to operating pressure. Operating pressure is expected to be about 6,000 psi. The value will be determined when the system is designed. When the system reaches full pressure, the rotating drill string is withdrawn in precise, predetermined increments until the nozzles reach a predetermined position at the top of the waste, but at least 3 ft below the top grade. At this point, the high pressure is reduced to a low-pressure trickle flow. The drill stem is fully withdrawn, and the positional system realigns the drill string to a new predetermined position (on a 20-in. triangular pitch matrix).

If, during the down drilling, a refusal of further progress occurs, the drill string will be retracted and the system will be moved to up to four different locations on the compass, 6 in. from the original hole. If any one of these positions allows full insertion of the drill steel, then grouting will be performed.

Once the trickle flow of grout is started, it remains until the day's operation is over. A typical day will involve two 8-hr shifts of continuous operation in concert with the batch plant, followed by a back shift consisting of several operations. The final grouting operation of the day is to inject a fast-setting grout using the low-pressure grouting system directly on the top of the bermed area used to contain the grout returns. Just enough grout to cover the returns will be applied (nominally a few inches of grout). Grouting is to proceed on a 5-day rotation with the 2 weekend days set aside for preventive maintenance of the system.

2.5.6.2 Normal Shut Down, Backshift Operations. Immediately following the removal of the ISG delivery system, the top surface of the recently grouted region will be covered with at least 2 ft of clean INEEL soil and compacted with vehicle traffic.

Within the maintenance glovebox, the back-shift operating crew removes the subassembly (drill bit and nozzle) from the delivery system and replaces it with a clean-out manifold. The clean-out manifold connects to a mobile reception tank separate from the grout delivery system. Using a hose that extends outside the glovebox and a low-pressure delivery pump, clean water (approximately 200 gal) is flushed through the ISG system into the mobile water reception tanks. Once filled, these tanks are removed from the SDA, surveyed, and staged awaiting the results of sampling. After sampling results have been

confirmed, the tanks are dumped in a special laydown pit (presumably located in the batch plant area). Following this cleaning, the high-pressure pump, hopper, and low-pressure pump are cleaned by breaking fittings and by using high-pressure spray wands.

Simultaneous to this cleaning, a new drill bit and nozzle subassembly will be installed inside the glovebox. On an as-needed basis, the HEPA filtration systems on the drill string shroud will be replaced under radiation protection program supervision with the appropriate levels of personal protective equipment (PPE). Generally, these maintenance operations will be performed during weekend shutdowns. At this time, other planned preventative maintenance will also be performed.

After clean out, the system is ready for movement to a new position. The system move requires retraction of the MCS to ground containment barrier. After the barrier is lifted, but prior to system movement, the radiation protection program technicians survey the barrier surfaces. The interior system is decontaminated or loose surface contamination is locally removed prior to the move. Once the radiation protection technicians have certified that the system is safe to move, the MCS is moved into position for the next day's grouting. Once positioned over the preplaced grout containment sheet piling, the corners of the ISG delivery system are positioned by GPS, and the MCS-to-ground barrier is lowered just below the soil surface. Ancillary high-pressure pumps, hopper, and low-pressure pumps are moved along with the ISG delivery system.

These actions leave the system in the ready mode for the next day's grouting campaign. All grouting equipment is sealed to avoid debris in the pumping equipment. In addition, the pumping/hopper area will be temperature-controlled to avoid ice formation in low points.

2.5.6.3 Abnormal Operations. Below is a list of possible abnormal events and the operating procedures associated with each:

- **Plugged injection nozzles:** If an injection nozzle becomes blocked, the drill steel subassembly will be inserted into the glovebox and the subassembly (drill bit and nozzle) will be removed from the delivery system and cleaned out. A stiff wire will be used to clear blockage in the nozzle.
- **Failures in pumping equipment:** If a high-pressure pump component fails to the point that high pressure cannot be achieved, the high-pressure pump will be repaired immediately using the inventory of spare parts. If a failure occurs in potentially contaminated components, such as the top-swivel and all parts of the drill string, the system will be moved to the glovebox and cleaned or repaired.
- **Leaks in system swivels or connectors:** System leaks that occur in interior positions will be fixed by special, manned bubble-suited entry by the trained crew of operators. The system will first undergo a clean out within the glovebox and then the problem area will be repaired using spare parts. This includes complete change-out of the top swivel.
- **Subsidence events:** If a sizable subsidence event occurs, where the top surface of the pit or trench causes a breach in the containment such that the ventilation system cannot maintain negative pressure, the system will be shut down immediately. The system will then be cleaned out in the glovebox. A special series of jacks will be used to shore up the system until sufficient compacted soil is dumped into the subsidence area to allow resealing of the containment to the soil and continuation of operations.
- **Stuck drill steel in the pit:** In the event that a drill steel down-hole is lodged in the pit and cannot be withdrawn using roto-percussion, the steel will be removed by manned entry under radiation

protection program supervision using the appropriate PPE levels. The manned entry will be brief and will involve bracing the drill steel as low as possible with pipe wrenches and using the rotational hydraulics of the drill steel to twist off the stuck drill stem. Following this twist-off, a new section of steel will be added and the remote grouting process will be continued.

2.5.6.4 Emergency Operations. Possible emergencies during the ISG process include fire, explosion, sudden high-radiation field, or sudden uncontrolled pressurization of the grouting system.

The possibility of a fire is dependent on the type of grout used in the delivery system. The only grout considered for application in the SDA that has combustible tendencies is the WAXFIX grout. Even though WAXFIX is a paraffin-based grout, it is barely combustible. The other grout materials are all noncombustible. Nevertheless, in the event of a fire inside the ISG delivery system, the system will be shut down by remote control. The grout lines will be cleared by a pulse of water to make sure the grout does not cure within the components. The pulse of water will be valved into the system from a special water supply. Fire protection will also be provided by the MCS fire suppression system described in Section 2.7.5.

If an explosion occurs below grade or within the ISG delivery system, the system will be cleaned out by water flush prior to total shutdown for the ensuing investigation. The water flush will be initiated from the remote control if the remote system is still operable following the explosion.

If the operating limit for radiation dose is exceeded, the system will be shut down and cleaned out. After the source of the high alarm is determined (anticipated in a grout return), radiation protection specialists will survey the area and recommend a suitable shielding to be applied prior to resumption of operations.

If the system becomes stuck at an overpressure condition (due to plugging of nozzles or other components in the system), there are several operations. First, an automatic pump-clutch trip-out will be activated in the event of an over-pressurization above the safety trip value (probably above the operating pressure). If this clutch trip-out fails, the operator can disengage the clutch to the pump manually upon seeing the overpressurization event in the remote control room. This may result in a system stuck at a pressure higher than the operating pressure, primarily because the fluid is largely incompressible and the large cylinders of the positive displacement pump may not stop pressurizing the system instantaneously. In this event, a specially provided bleed valve will be remotely operated to reduce the system pressure. If the remotely controlled bleed valve will not open (because it is fouled by grout), then a manual bleed bolt in the system will be operated using appropriate Lexan shielding to contain any blast of grout.

2.5.7 Decontamination and Decommissioning

Once the useful life of an ISG delivery system is completed (after a predetermined number of hours of operation), there will be an attempt at decontamination of grouting equipment and disposition for disposal or excessing. For systems used on grouting pits and trenches involving only fission and activation products, much of the system can be decontaminated. After the system undergoes a wash-off operation for decontamination, it may be released for metal excess.

For systems used on TRU pits and trenches, the system cannot be decontaminated because of Pu/Am fines on some of the equipment. These systems shall most likely be sprayed with strippable coatings, disassembled under the containment system by a radiation protection supervised entry with the appropriate levels of PPE, and then packaged in 4 × 4 × 7-ft boxes for disposal.

The interior liners of the containment system can be packaged for LLW disposal for either system and the outer noncontaminated materials can be excessed.

2.6 Confinement Systems

The project confinement systems consist of the confinement structures and the HEPA filtered ventilation systems. Each of these confinement systems is discussed in this subsection.

2.6.1 Confinement Structures

The nature of the ISG process is to stabilize contaminated materials. Most of the hazardous materials are expected to remain in the ground and enclosed in the subsurface grout materials. The grout materials are thick and wet and tend to restrict the spread of contamination. Contamination can occur in the grout returns, on the drill stem, the drill bit, and under the drill string shroud that forms a portion of the primary containment. Therefore, contamination can spread and confinement of radionuclides is necessary.

Primary confinement is accomplished within the grout returns, grout forms, drill string shroud, and glovebox. Prior to moving the MCS into position over a target treatment area, the grout containment, consisting of sheet piling sections approximately 3 ft deep and 15 ft long, is mechanically driven into the overburden soil to form a confinement for the grout returns and clean grout cover. The plan dimensions of the grout containment are approximately 15 ft square. The MCS then moves into position over the area thus defined.

Secondary confinement is accomplished within the MCS structure envelope as described in Section 2.4, Facility Structure. The structure envelope is extended to the surface by the retractable, hydraulically-operated, rigid barrier called the MCS-to-ground barrier, which during drilling operations is inserted approximately 3 in. into the overburden soil.

Personnel will be controlling the drilling operations using remote controls. All drill control is done by a drill operator looking through a window in the operating gallery and assisted by video cameras and sensors. An operator using the glovebox will perform maintenance such as cleaning and flushing grout injection nozzles. Personnel using the glovebox will be located in the operating gallery, which is separated from the secondary confinement envelope.

2.6.2 Ventilation System

This subsection describes and identifies the confinement zone classifications, discusses the ventilation system during normal and upset operating conditions, and discusses how the ventilation system will be designed for passive safe shutdown.

2.6.2.1 Confinement Zone Classifications. For ventilation design purposes, areas of the ISG structure and associated confinements are classified as Confinement (pressure) Zones I, II, or III in accordance with criteria in the DOE-ID Architectural Engineering Standard 1551, Special Requirements for Nuclear and Sensitive Duty HVAC. A Confinement Zone III classification applies to areas where highly-radioactive materials are handled. A Confinement Zone II classification applies to areas where high levels of radioactive contamination could be present. A Confinement Zone I classification is assigned to operating areas and maintenance areas that are adjacent to Zone II and III areas. A classification of clean area is assigned to areas that are normally free of contamination. The following list describes each of the confinements and their confinement zone classification:

• Drill string shroud	Zone II
• Grout return forms	Zone II
• Glovebox	Zone II
• MCS interior	Zone II
• Air lock	Zone I
• Operating corridor	Clean
• Control room	Clean
• Change room	Clean
• MCS exterior	Clean
• Grout equipment weather enclosure	Clean.

The ISG ventilation system design ensures airflow is from the cleanest to the most contaminated confinement zones. The airflow enters through a back-draft damper or through the air lock to the MCS structure envelope interior. Then it flows from the MCS interior to the glovebox and drill string shroud.

The drill string shroud is a passive ventilation system, which exhausts when the shroud is compressed during drilling. The shroud exhausts through a HEPA filter back to the MCS interior. The glovebox vacuum draws air through the glovebox and exhausts through a HEPA filter to the exterior atmosphere.

A fan draws air from the MCS structure envelope interior and exhausts through a HEPA filter to the exterior atmosphere to maintain a continuous negative pressure.

A conventional heating, ventilation, and air conditioning (HVAC) system using a heat pump with auxiliary heater will provide a comfortable work environment for the workers in the control room/operating gallery and change room. The HVAC system is a once-through system without recirculation.

A heated weather enclosure provides for the grout pump and equipment during winter for freeze protection. This equipment will be located adjacent to and outside of the structure envelope.

2.6.2.2 Normal Operating Conditions. Inlet air into the ISG structure flows through a counterbalanced back-draft damper and roughing filter in the structure wall. The back-draft damper is adjusted to maintain the MCS interior static air pressure at -0.25 cm (-0.1 in.) water gauge with respect to outside ambient pressure.

2.6.2.3 Upset Conditions. All systems operate in normal mode upon a breach in confinement and when the structure is being moved. Upon a loss of normal commercial power, the following will occur:

- All dampers will close
- The exhaust fans will shut off
- Envelope skirting will be inserted if not already inserted
- Confinement will be maintained in passive (no airflow) mode.

All heating ventilating controls operate in normal mode during alarm conditions. Automatic interaction with these controls may be required by the detailed fire hazards analysis. If required, these controls will be provided in the FDSA.

2.6.2.4 Passive Safe Shutdown. The ventilation system is designed and constructed so that active systems are not required to achieve and maintain the facility in a safe shutdown condition. A passive shutdown strategy is an integral part of the system design.

The passive shutdown design ensures that in the scenario of a complete failure of all systems or a complete loss of power, the ventilation system will revert to a configuration with no unfiltered exhaust.

2.7 Safety Support Systems

Safety support systems are radiological instrumentation, nonradioactive hazardous material monitoring, effluent monitoring, closed circuit television, and fire protection. Each of these systems is described in the following subsections.

2.7.1 Radiological Monitoring Instrumentation

Radiological instrumentation will include alpha and beta-gamma continuous air monitors (CAMs) or equivalent for airborne radioactivity monitoring in areas of normal work activities. Stationary beta-gamma and alpha self-survey instruments for hand monitoring will be located in close proximity to the entrance of the MCS and the entry to the work area. Radiation area monitors are centrally located within the MCS to identify any high-radiation source. Portable self-monitoring instruments will be located at normal egress points and whole-body surveys on an Eberline PCM-2 or equivalent will be required. Radiological survey instrumentation will include portable radiation detection instruments, and contamination count-rate instruments, and will be maintained under control of the radiation protection organization. Air monitoring of the MCS exhaust will be conducted to evaluate any airborne radioactivity released to the environment.

2.7.2 Nonradioactive Hazardous Material Instrumentation

Portable instrumentation may include personal exposure monitors, personnel exposure sample pumps and media, and environmental contamination monitors. Nonradioactive hazardous material instrumentation will be maintained under control of the industrial hygienist assigned to the project.

2.7.3 Effluent Monitoring System

The release of radionuclides from the MCS exhaust flow will be monitored. The monitoring system will consist of an isokinetic system that meets ANSI and Health Physics Society (HPS) standard ANSI N13.1-1999. One sample actively monitors for alpha radiation and a second sample provides a sample of record to be sent for analysis. This sample will be evaluated for other hazardous chemicals. The representative samples will be obtained by using shrouded probes. The samples are sent back to the exhaust after analysis. A climate-controlled cabinet will be located at the base of the exhaust where the sampling and monitoring instrumentation will be located. Three annunciators for the cabinet will indicate low flow, low sample flow, and radiation alarms.

2.7.4 Closed-Circuit Television System

The closed-circuit television system will be used for video operations, surveillance, and documentation of required video recordings. The mobile drill rig video system will have several

cameras in the upper corners of the MCS compartment that houses the drill rig. These cameras are controlled and displayed locally for the drill operator. This video system will be a color system with high quality, horizontal line resolution.

2.7.5 Fire Protection FM-200 System

The fire suppression system for the MCS will be an automatic FM-200 gas system. FM-200 is a biologically and environmentally safe fire-extinguishing agent. The gas tanks, actuation devices, discharge header, and fire panel are installed on a skid as one unit. A spare gas tank is also located on the skid. The skid is mounted on the outside of the MCS. Gas discharge nozzles are located in each of the enclosed areas of the MCS. Gas lines from the skid to the discharge nozzles must be designed to be flexible enough to withstand movement when the MCS is mobile. Smoke detectors located in each of the enclosed areas actuate the system. The automatic venting system within the MCS will displace air if the system is actuated. The vents close once the FM-200 gas saturates the areas.

Local alarms will be visual and audible. Alarms will be located inside and outside the MCS. Sufficient time will be provided to allow personnel to evacuate the MCS before the FM-200 gas is released. A “hold release” push button located in the most occupied area of the MCS can be used if personnel need more time to evacuate the MCS than the system provides. A worker can push the button to delay the activation of the system. Once the button is released, the system picks up where it left off and releases the FM-200 gas after the remaining time has passed. The fire department shall be notified of fire by a radio transmission device.

Manual fire alarm pull boxes and actuations will be located inside and outside the MCS. The fire department brigade and personnel involved with the operation and maintenance of the MCS will be familiarized and trained in the operation of the FM-200 system.

A manned fire watch will need to be provided when the MCS is being moved to a new location. A watch will be required until containment is again established.

2.7.6 Portable Fire Extinguishers

Portable fire extinguishers rated for A-B-C fires will be located at exit doors and other areas of the MCS.

2.8 Utility Distribution Systems

2.8.1 Facility Potable Water System

Water is supplied by a 240-gpm deep-well pump (production pump) located in WMF-603. The water is pumped into the 946,353-L (250,000-gal) water storage tank (WMF-709). Potable water is supplied to buildings by two 250-gpm domestic supply pumps.

The ISG process will require water for the grout batch plant and flushing/cleaning the drill stem grout injection lines and nozzles. A permanent water line will be installed to the batch plant and a fire hose will be used to fill a 200-gal water tank mounted on the ISG structure. This 200-gal tank, and a pressure pump, will supply water to the glovebox for cleaning the injection nozzles.

Potable drinking water will not be provided in the MCS.

2.8.2 Breathing Air

Portable Grade-D breathing air will be used for entries into confinements. Entries into the drill rig area will be required to change out end plugged nozzles. These entries will be evaluated on a case-by-case basis to ensure that the proper engineering controls are in place and that the appropriate PPE levels are used.

2.8.3 Utility Distribution Systems

Electrical power is supplied from the 12.47kV power line from CFA. The feeder that was to supply the In-Situ Vitrification Project off of the main RWMC 12.5kV supply will be used to supply the power for the In-Situ Grouting Project. A 15kV armored cable will be brought across the surface of the SDA to the grouting location. The armored cable will be relocated as necessary for each change in grouting location. Physical protection for the cable will be fabricated as needed where traffic over the cable is required. A portable sectionalizer switch and transformer will be placed near the grouting location. The transformer will convert the 12.5kV to the 480V utilization voltage. All large motors will be powered by the 480V distribution system. Normal “house” loads, lights, and receptacles will use 120-208V fed from the 480V distribution system. Control and instrumentation voltages will use 24V DC.

The major loads requiring normal power are as follows:

- Support trailers
- Ventilation
- Heating for the Mobile Containment System
- Lighting for the Mobile Containment System
- Instrumentation
- Miscellaneous loads
- High-pressure grout pump
- Drill Rig
- Bridge Crane.
- The major loads requiring normal and alternate power are as follows:
 - Lighting for the Mobile Containment System
 - Ventilation for the Mobile Containment System
 - Instrumentation.
- The loads requiring normal and UPS power are as follows:
 - Fire detection and alarm systems (uninterruptible power is built into the fire detection and alarm system)

- Emergency lighting (uninterruptible power is built into the emergency lighting, system).

2.9 References

1. Abbott, D. G., Feasibility Study Preliminary Documented Safety Analysis for In Situ Thermal Desorption in the Subsurface Disposal Area, INEEL/EXT-03-00962, November 2003.

